Environmental Research and Consultancy Department

Departure Noise Mitigation: Summary Report

CAP 1691a

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Summary

Introduction

Heathrow, Gatwick and Stansted airports are designated for the purposes of section 78 of the Civil Aviation Act 1982. This enables the Secretary of State to impose requirements on departing or landing aircraft for the purpose of mitigating noise. These powers have been used to set noise limits for departing aircraft, which have applied at Heathrow since 1959, at Gatwick since 1968 and at Stansted since 1993.

In addition to the departure noise limits, a number of other noise controls are promulgated through the Section 78 notices for each London airport, including a height requirement immediately after take-off, a minimum climb gradient requirement, and track-keeping requirements.

The original limit values remained effectively unchanged until the government's decision of 18 December 2000 to reduce the limits by 3 dB during the day and 2 dB at night, following a review which was initiated in 1993. The current limits are 94 dBA (day, 0700-2300), 89 dBA (shoulder, 2300-2330 and 0600-0700), and 87 dBA (night, 2330-0600). There was also a revision to relate the limits to a fixed reference distance of 6.5 km from start of roll and a new allowance for departures in a tailwind.

The 2000 decision reaffirmed that the government's general aim in noise monitoring is to help reduce the impact of aircraft noise around airports. Specific objectives and measures include:

- encouraging the use of quieter aircraft and best operating practice;
- deterring excessively noisy movements by detecting and penalising them;
- measuring the effectiveness of noise abatement measures by analysing infringement rates.

Recognising that the noise limits had been in place for many years, the government announced in its March 2013 Aviation Policy Framework that ANMAC[1] would review the departure noise abatement procedures at the London airports, including noise limits and use of penalties, to ensure that these remain appropriately balanced and effective. This report summarises the main findings of that review. The full report is published as CAP 1691, which is available to download at www.caa.co.uk/cap1691.

[1] Aircraft Noise Management Advisory Committee. ANMAC advises the Department for Transport on technical and policy aspects of aircraft noise mitigation and track-keeping at Heathrow, Gatwick and Stansted airports. Its membership includes representatives of Heathrow, Gatwick and Stansted, those airports' consultative committees, the three airport scheduling committees, the CAA, NATS and the Department for Environment, Food and Rural Affairs (Defra).

To assist the reader with the discussion and interpretation of results, presentation slides that illustrate the main phases of a typical UK departure and briefly outline the associated responsibilities are also available in CAP 1691b (www.caa.co.uk/cap1691b).

Much of the work in support of this review was carried out by the CAA's Environmental Research and Consultancy Department (ERCD) in close collaboration with other members of the ANMAC Technical Working Group (TWG), whose membership is listed below.

ANMAC Technical Working Group membership	
CAA ERCD (Chair and Secretariat)	Stansted Scheduling Committee
Department for Transport	Technical Adviser to the Scheduling Committees
Gatwick Airport	Gatwick Airport Consultative Committee (GATCOM)
Heathrow Airport	Heathrow Community Engagement Board (HCEB)
Stansted Airport	Stansted Airport Consultative Committee (STACC)
Gatwick Scheduling Committee	NATS
Heathrow Scheduling Committee	

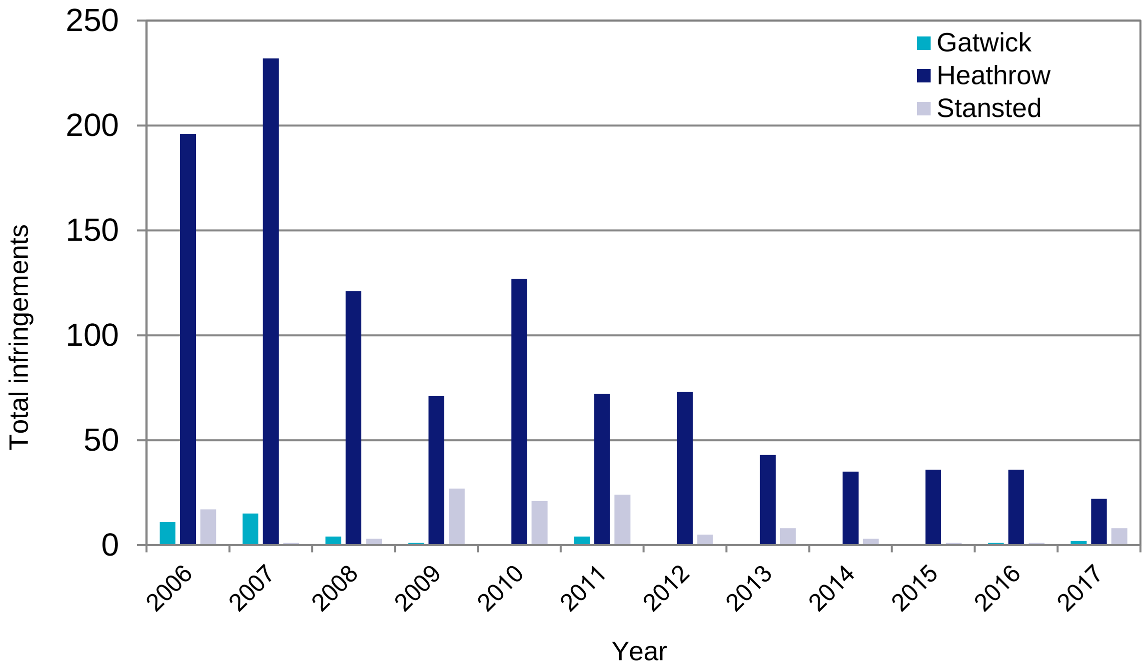
The Technical Working Group's terms of reference were:

- Conduct a review of the existing policy objectives and desired outcomes from a departure noise management regime in order to establish the criteria against which any revised proposals can be assessed. If appropriate, additional or alternative outcomes will be added to the criteria.
- Carry out a systematic review of the current departure noise abatement and monitoring procedures to understand how they help achieve the required outcomes.
- Without prejudice to the review of current procedures, assess the change in infringement rates for an increase in stringency of the current noise limits at Heathrow, Gatwick and Stansted. The current policy of applying uniform noise limits across the three airports should also be reviewed.
- On the basis of findings from these investigations, assess the potential for operational changes to mitigate any significant increase in infringement rate for aircraft of similar types.
- Assess the possible impacts of operational changes in terms of noise, emissions and any other significant factors.
- The Technical Working Group should report their findings back to ANMAC.

Noise limits

Government has stated previously that the primary purpose of the noise limits is to encourage the use of quieter aircraft and best operating practice. On this basis, the relatively low number of noise infringements over more recent years, as illustrated below, suggests the usefulness of the current limits may have diminished as aircraft have got quieter, and that there may now be scope to lower the limits.

Figure 1 Summary of annual departure noise infringements since 2006



The study by the ANMAC Technical Working Group has identified that there is limited scope for reductions in the noise limits at Heathrow until the retirement of the remaining Boeing 747-400 fleet. A small reduction of 1 to 2 dB in the daytime and shoulder limits might be feasible without causing the overall number of infringements to increase above historic levels.

The results for Gatwick and Stansted indicate that the current daytime, shoulder and night limits could be lowered, by up to 3 decibels or more in some cases, without significantly impacting the current fleets at those airports.

A lowering of the noise limits at Gatwick and Stansted would provide a backstop, dissuading the re-introduction of the noisiest aircraft types, but it would mean that the limits would no longer be applied equally across the three airports (which has been a matter of government policy for many years).

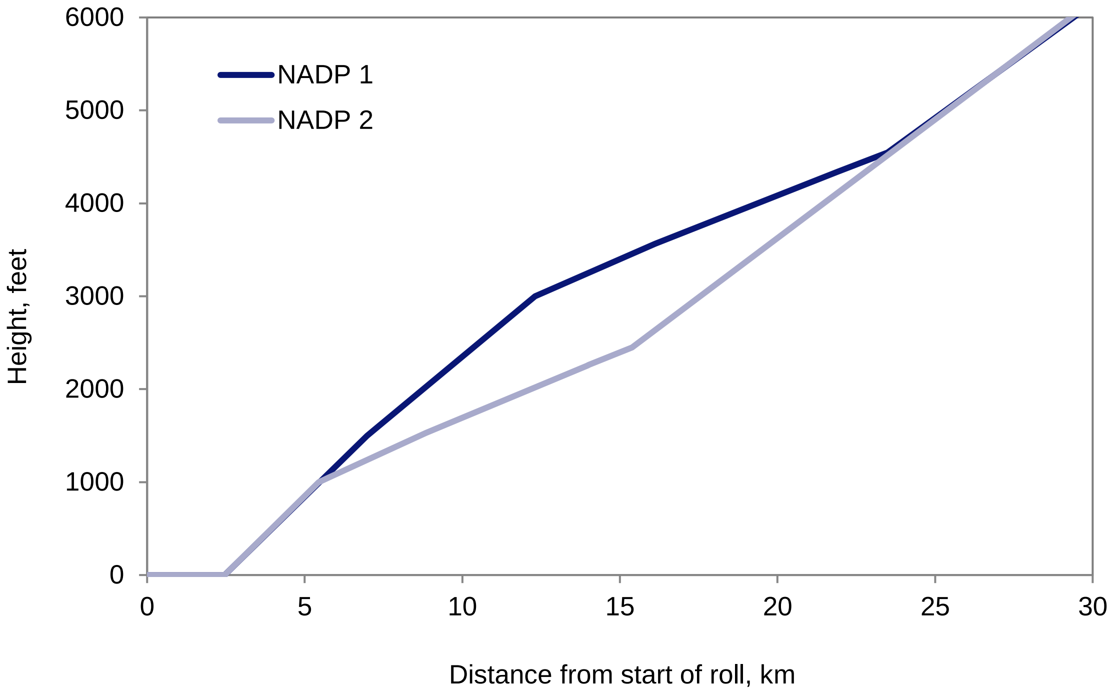
The analysis has shown that whilst reductions in noise level at the 6.5 km location could be achieved through changes to airline Noise Abatement Departure Procedures, this would be at the expense of noise increases elsewhere along or to the side of the flight path.

Regarding the wider influence of Noise Abatement Departure Procedures on departure noise, ICAO guidance provides two examples that were originally intended to provide distinct differences in noise exposure between close-in and distant communities from an airport: NADP 1 which ICAO notes can mitigate noise directly underneath the flight path close to the aerodrome, and NADP 2 which can mitigate noise more distant from the aerodrome. Although a wide range of procedures may be developed within the NADP 1 and 2 definitions, the following procedures are commonly implemented by carriers:

- NADP 1: Change to climb thrust at 1,500 feet, accelerate to climb speed at 3,000 feet
- NADP 2: Accelerate to climb speed and change to climb thrust at 1,000 feet

The difference between the height profiles for the two procedures is illustrated below for the Airbus A380 (3,000 NM trip length, reduced take-off thrust).

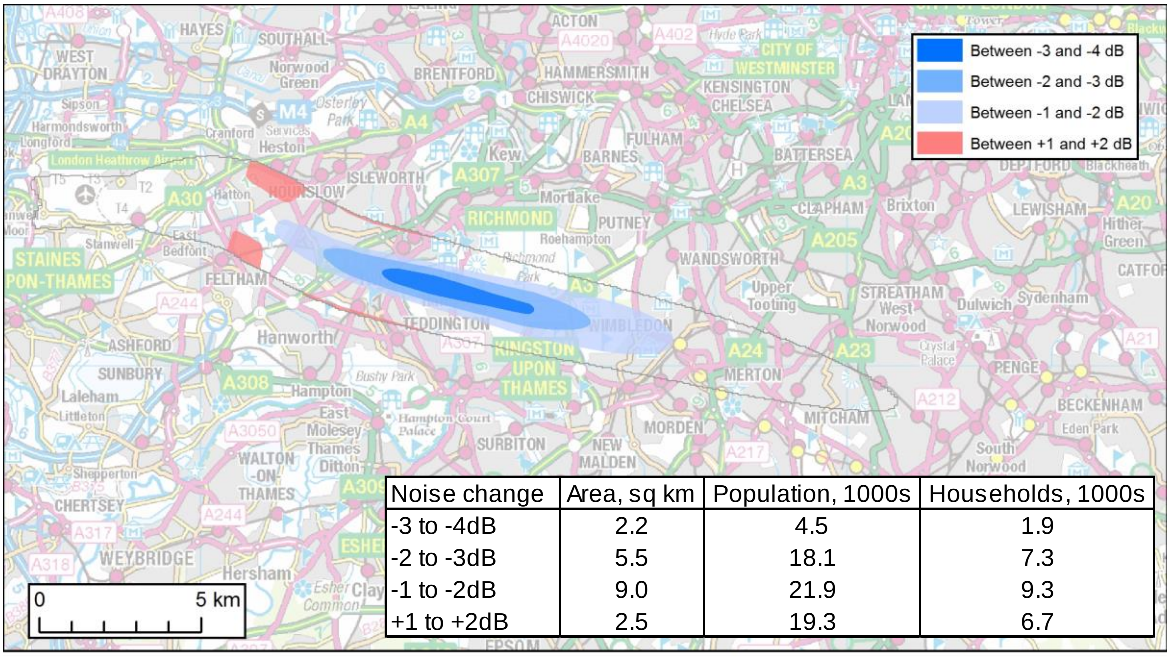
Figure 2 Comparison of NADP 1 and NADP 2 height profiles



Airlines tend to adopt noise abatement departure procedures that are compatible with their dominant base of operation, e.g. their central hub airport. Some airports direct airlines to use preferred procedures, though they have no formal power to enforce this, and in isolated cases it could cause an airline to breach EU regulations if the procedure directed by the airport was not one of the two adopted by the airline on a given aircraft type.

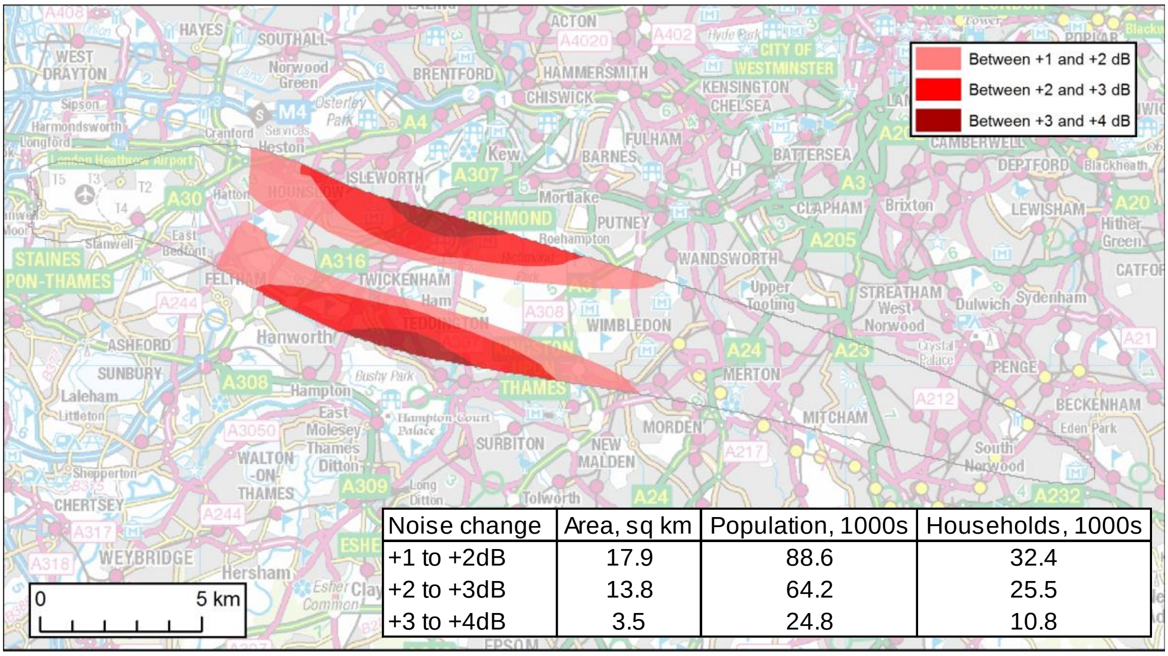
An NADP 1 procedure for the A380 was found to decrease L_{Amax} noise levels in some areas and increase L_{Amax} noise levels in other areas relative to NADP 2, but with more people overall experiencing less noise on the easterly Detling route at Heathrow (**Figure 3**). However, decreases in L_{Amax} occur as a consequence of increased height, but, at the expense of increased noise event duration, which when taken account of by the SEL noise metric, resulted in some people experiencing more noise and no people experiencing less noise (**Figure 4**).

Figure 3 A380 L_{Amax} noise differences on easterly Detling route for NADP 2 vs. NADP 1



Noise change	Area, sq km	Population, 1000s	Households, 1000s
-3 to -4dB	2.2	4.5	1.9
-2 to -3dB	5.5	18.1	7.3
-1 to -2dB	9.0	21.9	9.3
+1 to +2dB	2.5	19.3	6.7

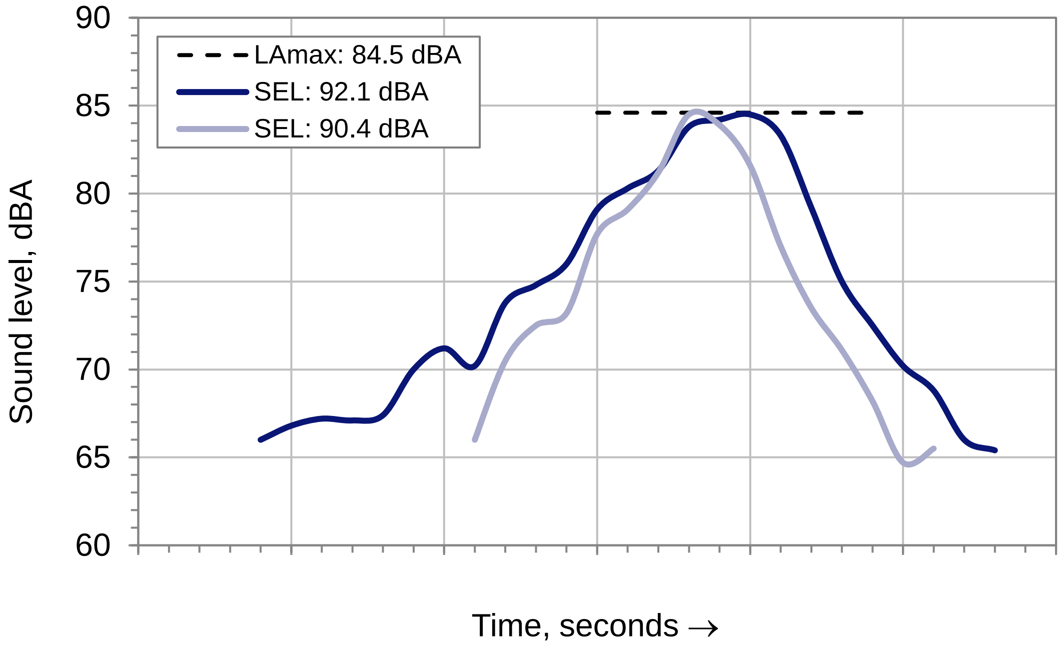
Figure 4 A380 SEL noise differences on easterly Detling route for NADP 2 vs. NADP 1



Noise change	Area, sq km	Population, 1000s	Households, 1000s
+1 to +2dB	17.9	88.6	32.4
+2 to +3dB	13.8	64.2	25.5
+3 to +4dB	3.5	24.8	10.8

The differences in **Figures 3 and 4** occur because L_{Amax} does not take account of the duration of the noise event (which is influenced by the speed of the aircraft). NADP 1 reduces L_{Amax} by gaining height but also increases the event duration. SEL on the other hand accounts for the duration of the noise event as well as its intensity. This means that two different aircraft noise events can have the same L_{Amax} value but different SELs, as illustrated in **Figure 5**.

Figure 5 Noise events with the same L_{Amax} and different SEL



Variations in the local population distribution along each departure route will therefore influence the resulting noise exposure for a given departure procedure. Identifying the optimum procedure(s), whilst respecting the two procedure EU-OPS limitation, is a matter for individual airports, airlines and their communities. The analysis shows that there is no single NADP that will reduce departure noise in all locations; a change of NADP simply moves noise from one location to another.

Changing from an NADP 2 to an NADP 1 procedure was shown to cause a decrease in NO_x up to 3,000 feet, but no change below 1,000 feet. This is because the NADP 1 departure climbs to 3,000 feet more quickly, but the two procedures are identical up to 1,000 feet. As a result, there is little difference in local air quality impacts. However, CO_2 (fuel burn) was shown to increase slightly when changing to an NADP 1 procedure because the aircraft cleans up and accelerates at a later stage during the departure.

The study also examined alternative take-off and climb power settings. Whilst it found that some combinations of take-off power and climb power achieved lower noise levels at 6.5 km from start of roll, these were at the expense of noise increases elsewhere, both directly underneath and to the side of the flight path. Higher take-off power was also found to significantly increase NO_x emissions below 1,000 feet.

Other noise controls

In addition to the departure noise limits, a number of other noise controls are promulgated through the Section 78 notices for each designated London airport.

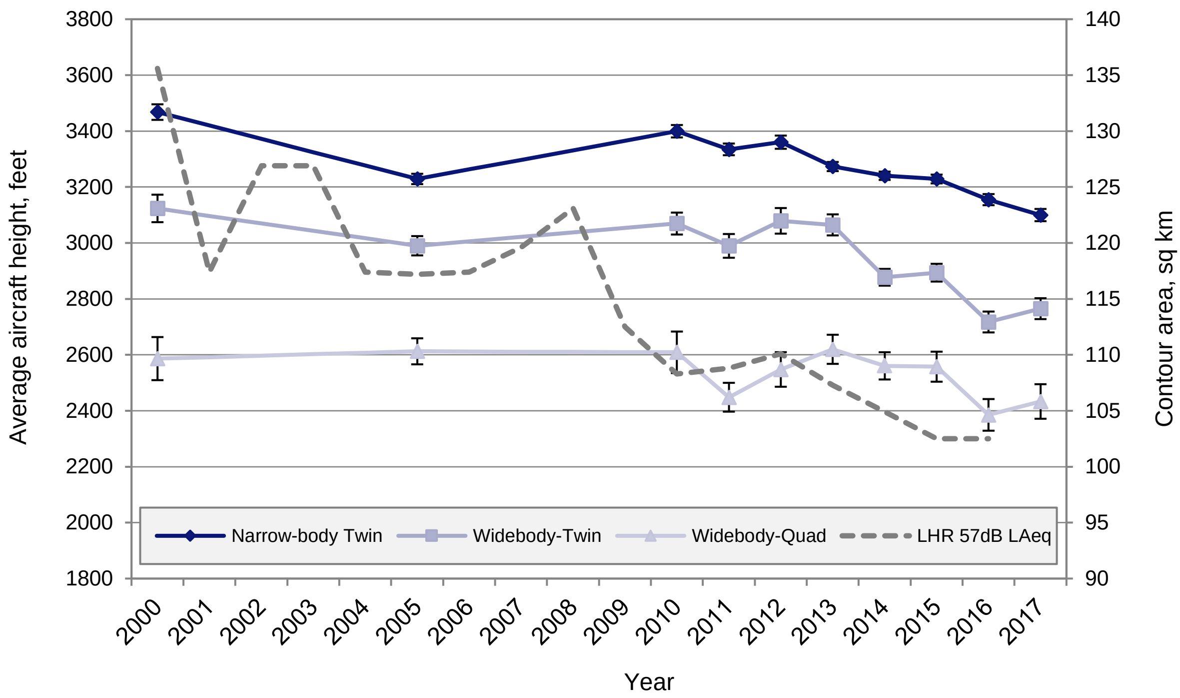
Aircraft are required to be at a height of not less than 1,000 feet at 6.5 km from start-of-roll. After passing the 1,000 feet point (at 6.5 km), aircraft are then required to maintain a climb gradient of not less than 4% to an altitude of 4,000 feet. The compliance rates with these additional controls are very high.

The rationale for the climb gradient requirement is to ensure that progressively reducing noise levels at points on the ground under the flight path are achieved.

Aircraft climb performance

There is continuing community expectation to minimise aircraft noise, and some local communities have expressed concern that aircraft climb performance is reducing, and that this could be sub-optimal for noise in those communities. A gradual decrease in average aircraft heights at Heathrow has been observed over recent years (up to 400 feet lower in some instances, see **Figure 6**). However, lower heights have not led to overall noise increases due to the continued introduction of quieter aircraft types, replacing older, noisier types.

Figure 6 Average aircraft heights at 11 km from start of roll, 09R Detling route, 2000-2017



Three main reasons have been identified for the observed decreases in average aircraft heights on departure over time:

- New generation aircraft and engines have a much greater scope for optimisation of thrust to minimise engine stress, noise, emissions and costs, which may partly explain some of the observed decreases in average aircraft heights in the three broad categories of aircraft over time.
- There is some evidence that airline departure procedures have changed over time causing aircraft to be lower than previously.
- Aircraft are getting larger/heavier. Smaller aircraft are gradually being replaced with larger aircraft and passenger loads are increasing.

Recommendation

Although the current controls appear to be limiting noise further out and compliance rates are very high, continued community discontent with departure noise in general suggests that the existing controls may not be sufficient to meet the concerns of the community.

Given the continued community expectation that departure noise should be minimised, additional departure monitors located beyond 6.5 km from start of roll would help to verify that progressively reducing noise levels under the flight path are being achieved. Additional monitoring could help to further incentivise airline performance, improve transparency and enhance community engagement. The question as to whether the monitors should be subject to supplementary infringement ‘limits’, advisory ‘levels’ or simply routine airport monitoring would need to be addressed.

The current departure limits are defined in terms of a maximum A-weighted noise level, L_{Amax}, which is the simplest measure of a noise event such as the overflight of an aircraft. However, as was highlighted in the NADP analysis, it does not take account of the duration of the noise event and hence is possibly less representative of the disturbance the aircraft may cause. It may therefore be preferable to define any new supplementary levels in terms of SEL, which would complement the existing 6.5 km L_{Amax} noise limits.

It is recommended that guidance be developed on the application of supplementary departure noise monitoring and associated levels. This could be taken forward through an industry-led group to develop an updated Departures Code of Practice. In the short term however, a voluntary arrangement at each airport may be appropriate.

APPENDIX A

Glossary

CO_2	Carbon dioxide.
dB	Decibel units describing sound level or changes of sound level.
dBA	Units of sound level on the A-weighted scale, which incorporates a frequency weighting approximating the characteristics of human hearing.
ERCD	Environmental Research and Consultancy Department of the CAA.
L_{Aeq}	Equivalent sound level of aircraft noise in dBA, often called 'equivalent continuous sound level'. For conventional historical contours this is based on the daily average movements that take place within the 16-hour period (0700-2300 local time) over the 92-day summer period from 16 June to 15 September inclusive.
L_{Amax}	The maximum sound level (in dBA) measured during an aircraft fly-by.
NADP	Noise Abatement Departure Procedure.
NATS	The UK Air Navigation Service Provider.
NM	Nautical Mile, equivalent to 1,852 metres.
NO_x	Nitrogen oxide (or oxides of nitrogen).
SEL	Sound Exposure Level. A single event noise level that accounts for both the level and duration of an aircraft noise event.